

EVALUATION OF RANDOM BOULDERS
FOR STREAM IMPROVEMENT IN ROCK CREEK

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INTRODUCTION

Stream improvement projects are undertaken by the U. S. Forest Service for erosion control, stream bank stabilization, and to directly improve fish habitat. These projects usually involve the use of structures such as gabions, trash catcher dams, boulders, and various other forms of log and rock dams and deflectors. Projects constructed to improve fish habitat too often are not preceded by sufficient physical and/or biological data to allow proper evaluation of the "improvement" to the fishery. Adequate preproject data are mandatory to properly evaluate such projects and show their value as stream improvement measures.

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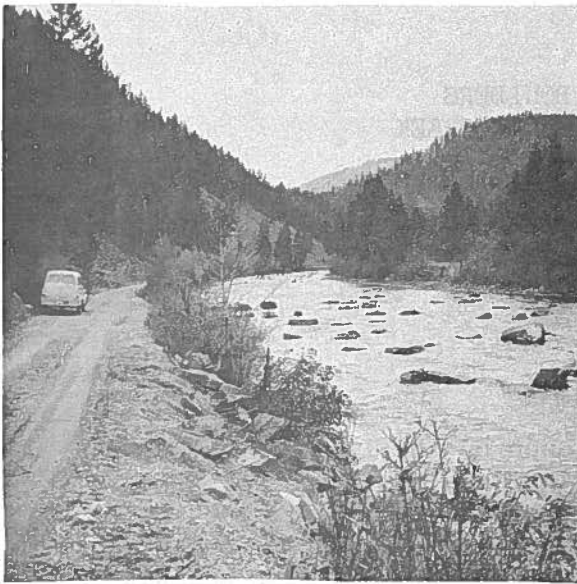
Such a project was undertaken on Rock Creek, a "Blue Ribbon" trout stream entering the Clark Fork River about 25 miles east of Missoula, Montana. Rock Creek is fast flowing and is characterized by a lack of pool-type habitat. Typical of most of the fishing water are long, fast, often straight and rather shallow riffles and runs. Deep holes occur only infrequently in the 50 miles of stream. Rainbow trout is the principal species caught by anglers, although cutthroat, brook and brown trout, Dolly Varden, and mountain whitefish are also taken.

In 1966 the Forest Service conceived the idea of placing large boulders in a fast, straight, rather shallow section of Rock Creek to create more pools and improve the habitat. A 300-foot study section with an average width of 114 feet was established in T9N R17W Sec. 30 near Walquist Creek, a tributary stream. The Montana Fish and Game Department was asked to census the fish population prior to placement of the boulders.

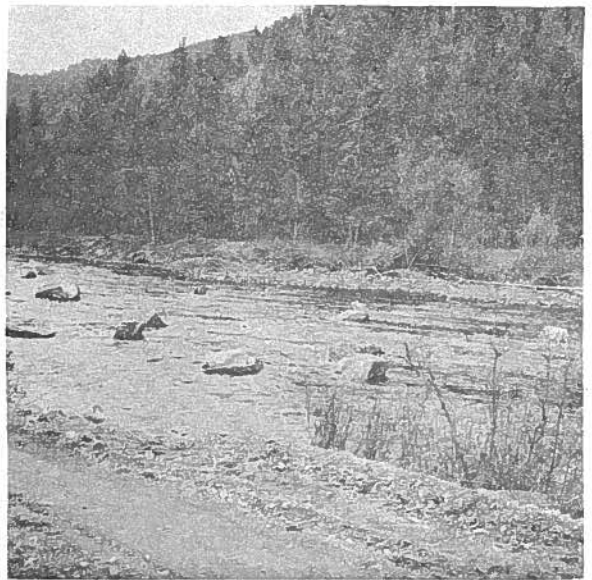
On September 16, 1966, the fish population in the study section was censused with electrofishing gear. The large boulders were then placed randomly within the limits of the section to create pools (Figure 1). Sixty-four (64) boulders were placed randomly within the 34,200 square-foot section, or one boulder for each 534 square feet of stream.

On September 16, 1969, the same 300-foot section (section A) was electrofished. In addition, another 300-foot section (section B) upstream from, and adjoining section A, was electrofished. This section did not contain boulders but was shocked in an effort to obtain 1969 fish population data to compare with section A. Section B was not censused prior to boulder placement.

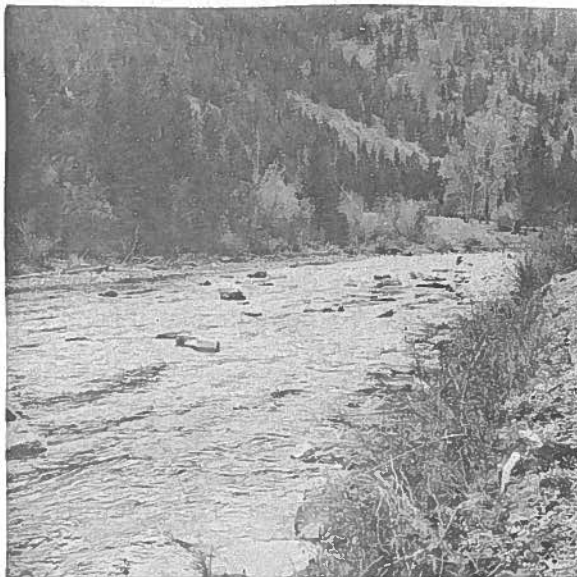
¹ A Classification of Montana Fishing Streams. Stream Classification Committee-Bureau Sport Fisheries and Wildlife, Montana State Univ., Mont. Fish and Game Dept. 1965.



No. 1 - Upstream view



No. 2 - Upstream view



No. 3 - Downstream view



No. 4 - View across (East - West)

Figure 1. Rock Creek study section showing location of large boulders placed by U. S. Forest Service for habitat improvement. Photo No. 1 shows section A (with boulders) and section B (without boulders immediately upstream). Also note additional area of boulder placement further upstream from section B. Photos by F. Tevebaugh. 10-17-66.

METHODS

Fish Population

Permanent markers were installed to mark section boundaries. Block nets were placed across the stream to prevent fish from entering or leaving the area during the electric census. Different electrofishers were used in 1966 and 1969. Both units were powered with 115-volt AC generators. However, the electrofisher used in 1966 converted the AC current into only half-pulse, direct current (DC). The unit used in 1969 could convert AC current into half-pulse, full-pulse, or continuous DC. About 350 volts and $1\frac{1}{4}$ amperes pulsed DC were the maximum obtained in 1966, while a maximum of about 480 volts and $1-1\frac{1}{2}$ amperes continuous DC were obtained in 1969. The 1969 unit is considered more efficient than the 1966 model, and continuous DC was more effective than pulsed DC for capturing fish in this section.

No population estimates were made; catch per effort was used to detect changes in fish population. Captured fish were measured and weighed. Stream flow was approximately the same in both years.

Cross-sections

Following high water of 1967, a definite change in bottom contour was observed in section A where boulders were placed. To substantiate this observation, depth measurements were made along transect lines established within sections A and B. Twenty-five transects at intervals of 25 feet were measured. Transect lengths, i.e., channel widths, were measured with a tag line (a marked $1/32$ -inch steel cable). Depth measurements were made with a velocity head rod along each transect at five-foot intervals, or more frequently if a gross change in bottom contour was evident. The water level in the stream remained constant while all measurements were made.

Depths were plotted on standard cross-section paper (10 x 10 to the inch). The cross-sectional areas were then measured with a hatchet planimeter to determine how changes in bottom contour affected the volume of habitat available for fish. Depth measurements were not made in section A prior to placement of the large boulders. Therefore, section B was substituted for section A and measured as an area unaffected by the project. From outward appearances sections A and B were very similar in nature before boulder placement and, therefore, it is assumed section B is representative of section A before the boulders were added.

Transects were numbered beginning at the downstream end of section A. Transects 1 through 12 were within the boulder area (section A), transect 13 was a transition area, and transects 14 through 25 were within the control area (section B).

RESULTS

Fish Population

Data on the game fish captured in 1966 and 1969 are shown in Table 1. No hatchery fish were stocked or captured in 1969.

TABLE 1. Species, number, percent composition and length and weight of game fish captured in Rock Creek in 1966 and 1969

Section & year	Species	No.	%	Length (in.)		Weight (lb.)		Total
				Range	Ave.	Range	Ave.	
A 1966 (w/o boulders)	Wf	99	65.6	4.1-13.7	9.4	.02-1.13	.30	32.68
	Wild Rb	28)	18.5)	3.3-15.2	7.9	.02-1.49	.35	9.83
	Hat. Rb	19)	12.6)	8.9-11.3	8.8	.29- .57	.39	7.42
	DV	4	2.6	7.1-12.3	9.6	.13- .67	.37	1.48
	Ct	1	0.7	6.7	6.7	.13	.13	.13
		<u>151</u>	<u>100.0</u>					<u>51.54</u>
A 1969 (w/boul- ders)	Wf	94	54.0	6.0-15.1	9.8	.07-1.40	.34	31.62
	Rb*	71	40.8	2.7-14.1	7.6	.02-1.07	.27	19.03
	DV	6	3.5	5.9-11.2	8.1	.06- .46	.20	1.18
	Ct	3	1.7	5.6-10.5	8.4	.07- .40	.24	.73
		<u>174</u>	<u>100.0</u>					<u>52.56</u>
B 1969 (w/o boulders)	Wf	52	62.6	3.7-13.5	9.5	.02- .78	.35	18.01
	Rb*	28	33.7	2.8-13.9	6.8	.01-1.05	.19	5.28
	DV	2	2.4	6.0- 6.7	6.4	.06- .10	.08	.16
	Ct	1	1.3	5.4	5.4	.05	.05	.05
		<u>83</u>	<u>100.0</u>					<u>23.50</u>

Wf=mountain whitefish; Rb=rainbow; DV=Dolly Varden; Ct=cutthroat
*All wild Rb

The rainbow trout is considered to be the most important game fish for this purpose and the analysis primarily considers this species. A 7-inch fish is considered a "catchable." Rainbow were divided into two groups--catchable (7 inches and over), and non-catchable (under 7 inches). The numbers, weights and percentages in each group are shown in Table 2. The 1966 group is listed both with and without hatchery rainbow.

TABLE 2. Numbers and weight, and percent of catchable and non-catchable rainbow trout captured, by section, from Rock Creek, 1966 and 1969

Sec. A - 1966 (w/o Hat. Rb)				Sec. A - 1969			
Size	No.	Wt.(lbs.)	%	Size	No.	Wt.(lbs.)	%
Under 7"	10	0.72	36	Under 7"	44	3.38	62
7" & over	18	9.83	64	7" & over	27	15.65	38
	<u>28</u>	<u>10.55</u>	<u>100</u>		<u>71</u>	<u>19.03</u>	<u>100</u>
Sec. A - 1966 (w/Hat. Rb)				Sec. B - 1969			
Size	No.	Wt.(lbs.)	%	Size	No.	Wt.(lbs.)	%
Under 7"	10	0.72	21	Under 7"	22	1.75	78
7" & over	37	16.53	79	7" & over	6	3.53	22
	<u>47</u>	<u>17.25</u>	<u>100</u>		<u>28</u>	<u>5.28</u>	<u>100</u>

Although numbers of rainbow varied with size groups between 1966 and 1969, the total biomass of all rainbow was not too different between years. The total weight in section A in 1966, including hatchery rainbow, was 17.25 pounds compared with 19.03 pounds in 1969, a difference of 1.78 pounds. The weight of catchable rainbow only was 16.53 pounds in 1966 and 15.65 pounds in 1969, a difference of 0.88 pounds. The total weight of all species combined in section A, including hatchery rainbow, was 51.54 pounds in 1966 and 52.56 pounds in 1969, a difference of 1.02 pounds.

Hatchery fish were stocked in June, 1966 within 300 feet of section A. Their effect on wild fish is not precisely known, but it is interesting to note that 50 percent of the 1966 catchable rainbow catch was comprised of hatchery fish. Studies undertaken in other Montana streams are bringing forth the idea that wild rainbow are displaced (at least temporarily) by planting catchable hatchery rainbow trout. This phenomenon may have occurred in section A in 1966. If the assumption is made that after about three months in the stream (June - September) the hatchery fish had indeed displaced approximately equal numbers and weight of wild rainbow, it would lead to the conclusion that the boulders did not significantly affect the fish production of section A in terms of biomass.

Section B was censused in 1969 to compare fish population data with section A. Section B was considered an unaltered section even though boulders had been placed further upstream from it (see Photo 1 in Figure 1). Gross examination of section B indicated no effect of these upstream boulders on the bottom contour.

Section B had about half the number of catchable rainbow as section A. However, since no 1966 population data is available for section B, the 1969 data loses much of its value.

Cross-sections

The plotted cross-sections are shown in Figure 2. The number of depth measurements made along each transect ranged from 21 to 36 (average 27) in section A and from 21 to 29 (average 25) in section B. More points were measured in section A because of the greater irregularity of the streambed.

Channel widths ranged from 99 to 129 feet (average 114 feet) in section A and from 104 to 125 feet (average 116 feet) in section B.

Water depths in section A ranged from 0.1 feet to 2.3 feet. Average depth was 1.2 feet. In section B water depths ranged from 0.1 feet to 1.9 feet with an average depth of 1.2 feet.

The combined cross-sectional area of the 12 transects in section A was 18,140 square feet and in section B was 18,250 square feet. The average cross-sectional area in section A was 1,512 square feet and in section B 1,521 square feet.

No difference occurred in cross-sectional area between sections A and B following placement of boulders. Because both stream banks were stable, the boulders caused physical alterations to occur only in the streambed.

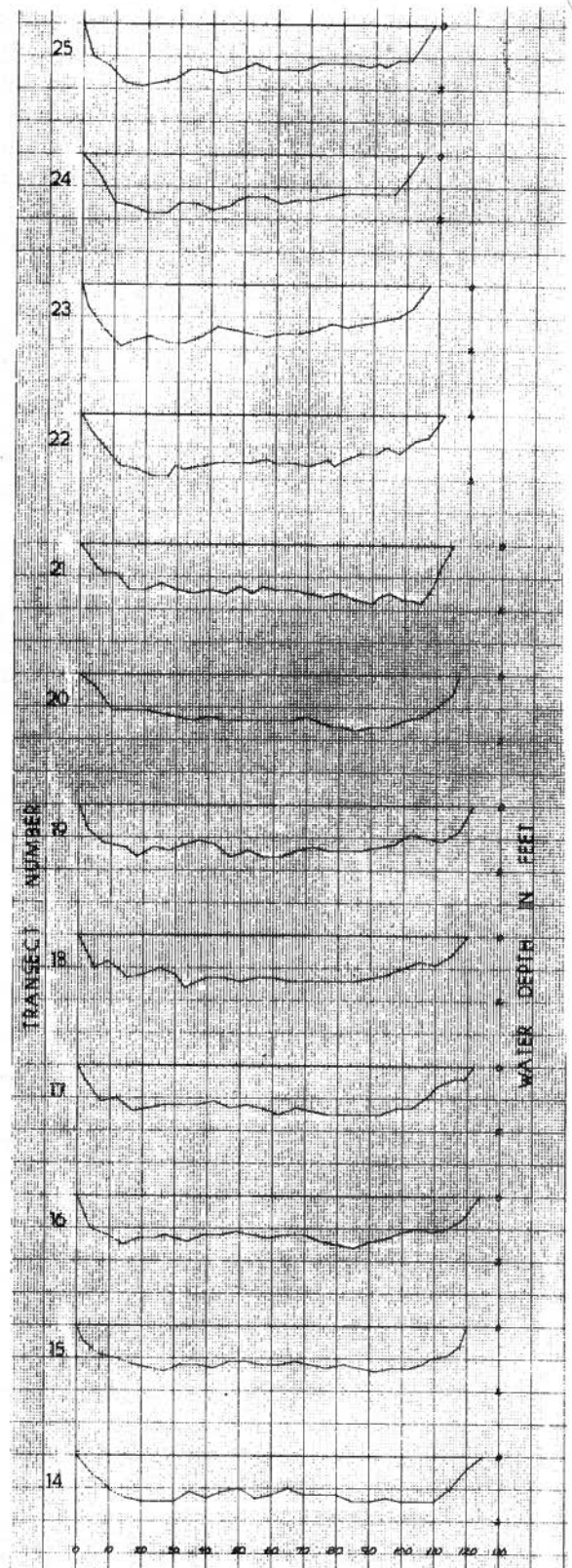
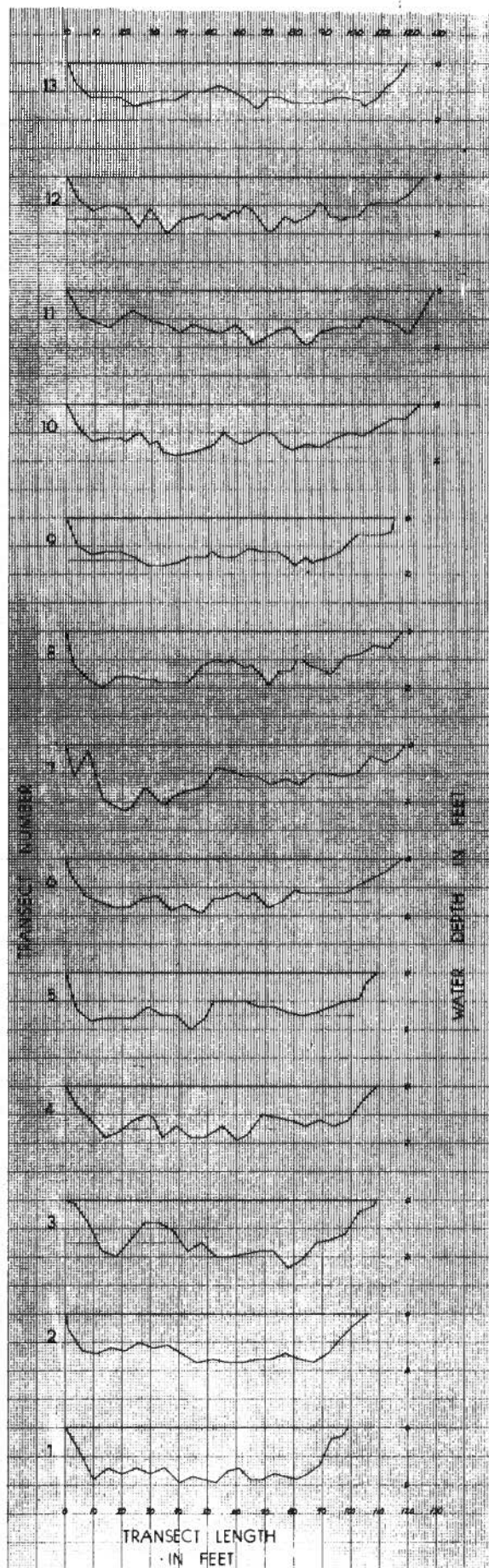


Figure 2. Cross-sections constructed by plotting water depth measurements taken every five feet, or less, along each transect in study section. Transects 1-12 are in section A, 13 is transition area, and 14-25 are within section B.

The scouring action of the current transposed the bottom materials in section A so that the total volume of potential fish habitat was not changed by the boulders.

To further determine any differences in volume of fish habitat between sections, the number of points at least 1.0, 1.5, and 2.0 feet deep was determined for each transect. The number of these points along a transect were divided by the total points measured along the transect to obtain the percent of depth in each category. These data are shown below for each section:

	% depth at least		
	1.0'	1.5'	2.0'
Section A	85	37	4
Section B	92	25	0

These data show the influence of the boulders in changing the streambed contour. Section B had a more uniform contour than section A and therefore had fewer points that were less than 1.0 foot deep. This was due to deposition of bed materials in some areas while other areas were deepened by scouring in section A. The net effect was the same total cross-sectional area but a new configuration. Water deeper than 1.5 and 2.0 feet occurred more often in section A than in section B, whereas section B, with fewer deposition areas had more water at least 1.0 foot deep. Deep water generally was measured between boulders. Shallow water was measured in deposition areas downstream from and behind the boulders.

Observations during electrofishing indicated that the pools behind single, isolated boulders did not provide suitable escape cover. Pools were generally quiet and clear, with smooth water surfaces - apparently unattractive hiding places for fish. On the other hand, good cover occurred between boulders which were clustered and about 3-5 feet apart (Figure 1, No. 4 - foreground). This arrangement created deep, fast water with a rough surface. More fish were captured from these areas than from the pools behind single boulders. This is not to imply that fish never occupy the more quiet pools. However, when disturbed they apparently did not remain there, but sought the more secure areas of deeper, rougher water.

CONCLUSIONS

In comparing the physical differences between section A and section B following placement of boulders it was found that addition of boulders to section A deepened areas between boulders while making areas behind boulders more shallow. Because the channel banks were stable, all changes in the section occurred in the streambed. Average channel depth did not change when boulders were added. The total cross-sectional area of section A was not changed when boulders were added. Only the bottom configuration was altered.

Treatment with boulders did not change the total biomass of all species (Table 1) or the biomass of catchable rainbow (Table 2) in section A. There

was an increase in smaller rainbow in 1969. Differences in shocker efficiency could account for some of the increase in numbers of smaller rainbow trout or the boulders may have concentrated the fish and made them easier to catch. The presence of hatchery rainbow trout in 1966 and not in 1969 further confused the picture, since in 1966 hatchery fish comprised over 50% of the rainbow over seven inches long. As mentioned, hatchery fish may have displaced equal numbers of catchable wild fish. Species composition before and after boulder treatment was not markedly different. Average size of rainbow trout in section B was less than in section A.

COMMENTS

Three factors which, had they been more adequately planned for in this study, would have increased reliability of the data are as follows:

- (1) Greater lead time prior to electrofishing in 1966 would have allowed the Department to change the location of hatchery fish plants so these fish would not have entered into the analysis. Hatchery fish were stocked in June.
- (2) Cross-sectioning should have been planned and completed in section A before the boulders were placed. A control section censused before and after the project would have been desirable to detect gross changes in fish populations in an unaltered section. This would have eliminated the need for a substitute section (B) with associated unknowns and assumptions.
- (3) The addition of boulders to the area further upstream was untimely. Even though their influence might have been slight, they should not have been placed in the stream prior to obtaining results from the study section.

The presence of these variables points out the need for proper planning before a project becomes active.

FUTURE GUIDELINES

The following statements are intended as guidelines for future projects of this nature. It is recognized that every stream is unique in its characteristics and that each may react differently to stream improvement measures. The degree of channel damage or need for improvement will determine the type of improvement measure to use.

- (1) In streams the size of Rock Creek, single, isolated boulders should not be used, or used sparingly, for habitat improvement. Boulders should be clustered in the stream and spaced from 3 to 5 feet apart to create deep water areas with a rough water surface. The distance between boulders should probably be adjusted in smaller or larger streams.

- (2) Evaluation projects of this nature should be thoroughly planned to obtain the best information. Complete physical and biological data should be obtained both before and after the project so adequate comparisons can be made. An evaluation of the same area before and after treatment is highly desirable (as is evaluation of a control area before and after), and enables more reliable conclusions to be drawn than do substitute areas. This was not adequately done in this evaluation.
- (3) Stream fishery improvement projects should be used in areas which have definite habitat problems. This was not the case with the Rock Creek project.

